



Economic Viability of Wet Season Aromatic and Non-aromatic Rice Cultivation in Dinajpur District of Bangladesh

Mohammad Jahangir Kabir^{1,*}, Md Abdus Salam¹, Alvira Farheen Ria², Aabu Bakr Siddique¹

¹Agricultural Economics Division, Bangladesh Rice Research Institute, Gazipur, Bangladesh

²Department of Environmental Science and Management, North South University, Dhaka, Bangladesh

Email address:

jkabirbri@yahoo.com (M. J. Kabir), aasalam_36@yahoo.com (Md. A. Salam), alvira1902@gmail.com (A. F. Ria),

abs_63@yahoo.com (A. B. Siddique)

*Corresponding author

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Abstract: The aromatic rice has cultural and economic significance in Bangladesh. This study assessed the relative economic viability (profitability and risk) of aromatic and non-aromatic wet season (WS) rice varieties. The farm-level data for this study was collected through face to face interview from Dinajpur. An enterprise, partial and stochastic budget was developed in the study. Nearly half of the total T. Aman area in the case study villages was devoted to aromatic rice, in particular modern aromatic cultivar BRRI dhan34, mainly due to it gave notable extra benefits over local aromatic (BDT. 13,519/ha) and non-aromatic (BDT. 20,197/ha) cultivars. There was no significant difference in yield between BRRI dhan34 and local aromatic variety, namely Kataribhog. However, BRRI dhan34 was found to be the more economically viable (gave higher returns and posed less risks) option due to its higher and stable market price. The higher price, guaranteed market demand, lower fertilizer requirements, shorter growth duration and suitability of late transplanting of BRRI dhan34 are the major drivers behind its widespread popularity in the region. It was clear from this research that farmers in the case study villages are highly motivated to increase adoption of the aromatic cultivar due to its price advantage and ensured market. Therefore, the development and dissemination of the higher yield potential biotic stress tolerant aromatic variety should get priority in policy planning for higher income generation and export earnings for the country.

Keywords: Aromatic Cultivars, Partial Budget, Economic Sustainability, Profitability, Risks

1. Introduction

Aromatic rice is widely used for cooking scented rice for religious and cultural festivals, and special family occasions. For Bangladesh, in particular, cooking exclusive dishes using this scented rice is a common phenomenon and plays an integral part in the country's social and cultural heritage. These dishes are served to entertain guests when celebrating festivals and special ceremonies. Serving scented rice to guests is even considered a matter of prestige and honour at weddings [22]. The aromatic rice has very high demand in both the domestic and international markets of wherever South Asian populations reside, be it permanent or temporary

[5]. As a result, the prices of aromatic cultivars are usually higher than that of non-aromatic varieties [3]. Furthermore, in Bangladesh, the rising GDP growth trend and observed negative elasticity, indicates that demand for the premium quality rice, non-cereal such as fish, meat, and egg tends to increase more rapidly [19, 20]. Due to this economic importance, there is a need for increasing the adoption of aromatic rice to meet domestic and international demands [23]. However, the aromatic rice is mainly grown in the wet season, and the adoption of aromatic cultivars rice was 12.5% of total wet season rice area in Bangladesh [3] and few areas adopted by aromatic rice cultivars in the dry season in Bangladesh [2].

Considering the significance of the scented rice, Bangladesh Rice Research Institute (BRRI) has released seven aromatic and premium quality rice cultivars; namely, BR5, BRRI dhan34, BRRI dhan37, BRRI dhan38, BRRI dhan70, BRRI dhan80 and BRRI dhan90 [4]. Besides, there are also a large number of local aromatic cultivars such as Kalijira, Chinigura, Kataribhog, Tulshimata, which have slender grains and pleasant aromas. Moreover, many varieties of these desirable traits were cultivated in the various locations in the country; however, they are not familiar to people outside those areas [2]. Therefore, it has been a challenge for the country to occupy international markets for aromatic rice, since lower yield potential local cultivar aromatic rice are adopted more often, leading to a low total surplus in the country. Traditional aromatic rice could not make higher profits either, due to their lower yield. It is also important to note that coarse rice has lower market prices, and this serves as one of the most crucial obstacles for rice cultivation in Bangladesh [4]. Instead, farmers might gain more economic advantages through the practice of the new genotype of aromatic rice.

In recent times, the cultivation of modern premium quality rice serves as the light of hope to farmers since the cultivation of aromatic rice has substantial comparative advantage in the view of export and import substitution [2]. The increased adoption of aromatic rice has the potential to create new avenues of higher benefits for the farmers while at the same time, earning more foreign currency by capturing the export market. However, the profitability and risk associated with a technology and farm enterprise is largely influenced farmers' decisions to adopt the technology or crop enterprise [12, 14]. Some studies assess the profitability and riskiness of rice/shrimp, rice/non-rice cropping system in coastal and drought-prone ecosystem [11, 13-17]. However, none of the studies found to estimate the profitability and riskiness of aromatic and non-aromatic rice in north-west Bangladesh. Thus, this study was carried out for an in-depth understanding of the economic insights of the most preferred aromatic rice. The specific objective of the study was as follows:

- (i) to evaluate adoption situation of aromatic and coarse rice varieties;
- (ii) to assess the relative economic viability (profitability and risk) of BRRI aromatic over other popular aromatic and coarse rice cultivars, and
- (iii) to outline farmers' perceived criteria and constraints of aromatic rice cultivars.

2. Methodology

2.1. Data Collection

A multistage sampling technique was followed for selecting the areas of the study. Firstly, the Dinajpur District was selected purposefully due to the region's higher adoption of aromatic cultivars in the wet season. Secondly, Chirirbandar Upazilla was chosen based again, on their higher adoption of the aromatic variety. Thirdly, two villages such as Barogram and Basantapur were selected, as the majority of the farmers there practiced aromatic rice

cultivation. Finally, sixty farmers in total, thirty from each village were selected randomly for face to face interviews during January, 2011. Besides, the farmers' perceived seasonal variability in yield and price, as well as their input use pattern data for aromatic and non-aromatic T. Aman rice was collected in 2017.

2.2. Budgeting

The profitability of farm enterprise can be evaluated using multiple economic tools, such as enterprise budgets, partial budgets, and whole-farm analysis. However, none of these methods can be called check-book accounting [7]. An enterprise, stochastic and partial budgeting technique were applied in the study for assessing profitability and the risk of aromatic and non-aromatic wet season rice cultivars.

2.2.1. Enterprise Budget

The collected data was cleaned before constructing the enterprise budget. The adoption of aromatic cultivars rice was 12.5% of the total wet season rice area in Bangladesh. The Herdt' 1978 approach, which made a vital distinction between cost items, was followed for constructing the enterprise budget. The paid-out cost is the actual cost of purchase inputs. The imputed cost is the unpaid cost of the family supplied inputs and the Gross benefit (GB) is the total value of grain and straw. Gross margin (GM) is the GB minus the Paid-out cost and the Net income is the GM minus Imputed cost [9]. The actual cost of purchase inputs hired labour, tillage, seed, fertilizer, supplementary irrigation, and insecticides was accounted as total paid-out cost. In contrast, the cost of the imputed input, such as family labour and seed was calculated using the shadow pricing approach.

2.2.2. Partial Budget

Partial budgeting is the most appropriate production economics analytical tool widely used for evaluating the consequences of relatively small changes in existing farms or methods. This tool is convenient to compare the profitability of alternative farm enterprises [6]. In this study, the partial budget analysis was developed to understand the economic advantage of BRRI aromatic rice cultivation over other rice varieties.

2.2.3. Stochastic Budget

Cropping systems, more specifically, in the rain-fed arid and semi-arid regions, are operated under various external risks, which arise from uncertainty in weather and infestation of pest and diseases, followed by economic changes in prices of input and government and social systems [1, 18]. In the study at hand, the @Risk software program version 7.5 was used for simulating risk-return tradeoff between aromatic and non-aromatic rice in 2011 and 2017. The farmers' perceived best, normal and worst seasonal yield, as well as the maximum, most likely and lowest price of aromatic and non-aromatic rice in 2011 and 2017, were used to run the Monte-Carlo simulation. In total 10,000 iteration was run for the simulation to estimate risk and return trade-off.

2.3. Empirical Technique

Descriptive statistics was used to analyzing the data. Tabular and graphical techniques were used for presenting the outcome as mean and percentage etc.

Application of Independent t-Test for Mean Difference for dominant aromatic and non-aromatic Rice

$$\sigma(X_1-X_2)=\sqrt{(\sigma_{x1})^2 + \sqrt{(\sigma_{x2})^2}} \quad (1)$$

and $\sigma_x = \frac{\sigma_x}{\sqrt{n}}$

where

- $\sigma(X_1-X_2)$ =The standard error of difference between means
- σ_x =Standard error
- n =sample size

We have to see whether or not the actual difference exceeds $2\sigma (X_1-X_2)$. If it does not, the population means are most unlikely to be same. In statistical jargon, it should be said that the difference between the means is significant at the 95% level of confidence and therefore the population does not have the same mean [8].

3. Results and Discussion

3.1. Aromatic Rice Production Situation

In the wet season, the Indian variety Swarna was a dominant T. Aman rice variety, in addition to the coarse rice varieties BR11, Pajam, BRRI dhan33, BRRI dhan30, BRRI dhan32 and BRRI dha40 in the case study villages. The farmers of the villages also mainly grew some potential aromatic rice varieties such as BRRI dhan34 and the local aromatic variety Kataribhog. The survey revealed that the average farm size of the respondent farmers was 2.43 hectares. On average 75% (e.g., 1.81 hectares) of total arable land in the study villages was devoted to T. Aman rice cultivation. Farmers in the villages cultivate coarse rice for family subsistence, while they grow aromatic rice mainly as a cash crop. The adoption rate of aromatic rice was over half (53%) of the total T. Aman rice area, of which the adoption rate of BRRI dhan34 was a major (66% of total aromatic area) variety and gave higher yield and return. On the other hand, the adoption of the Indian cultivar named Swarna was the most popular (69%) among the coarse rice cultivars. A key finding of this study is that the farmers in these villages allocate a notable percent of T. Aman rice area for aromatic rice cultivation, indicating that rice cultivation in the area is not merely subsistence-oriented, but rather semi-subsistence farming.

3.2. Profitability of Aromatic and Non-aromatic Rice

3.2.1. Input Use Pattern

The survey revealed that the farmers used both family-supplied and purchased inputs for monsoon rice cultivation in the survey area, but relied less on the family-supplied inputs. Farmers mainly used household seeds and family labour for low labour intensive operations such as land preparation,

weeding and post-harvest processing. This indicates that farmers in these areas are mostly dependent on the hired labour, two-wheel power tractor, power thresher and inputs (fertilizers and pesticides) needed for rice cultivation.

Table 1 presents human labour and input use pattern of aromatic and non-aromatic (coarse) rice cultivations in Dinajpur. There was no large variation between per hectare human labour employed for the intercultural operations of aromatic (110 and 111 man-days for Kataribhog and BRRI34, respectively) and non-aromatic rice (119 man-days) cultivation. Furthermore, the participation of hired labour for intercultural operations was very high in the case of coarse rice. Although, the rate of application of other inputs, in particular seeds and fertilizers, was considerably higher in non-aromatic rice (seed 50 kg/ha and fertilizers 284 kg/ha) than that of aromatic (seed 39-42 kg/ha and fertilizers 189-197 kg/ha) rice cultivation. Besides, there was not much difference between the seed and fertilizer use of BRRI dhan34 and popular local aromatic cultivar Kataribhog.

However, the farmers' practiced seed rates were found to be largely higher than that of BRRI recommendation, irrespective of both aromatic and non-aromatic rice. This may be because of the low germination of household seeds and/or lack of knowledge on recommended seed rates. Also, the amount of fertilizer applied by farmers in aromatic rice was nearly half of what BRRI's recommends (Urea-165-195, TSP-60, MP-105-135, gypsum-68), and the fertilizer applied for non-aromatic coarse rice was much lower than the BRRI recommendations. Besides, farmers applied higher doses of fertilizer for coarse rice (284 kg/ha) than that of aromatic rice (189-197 kg/ha) (Table 1; [3]). Similarly, reported this observation as well, stating that farmers applied notably higher amounts of fertilizers for coarse rice (257 kg/ha) than that of aromatic (113 kg/ha) rice [10]. These results indicate that the aromatic rice cultivars are considerably less fertilizer intensive than non-aromatic coarse rice cultivars. Moreover, farmers apply less fertilizer than what is recommended, irrespective of aromatic and non-aromatic cultivars.

Table 1. Per hectare labour and inputs use pattern of aromatic and coarse monsoon rice cultivation in Dinajpur.

Items	Aromatic		Non-Aromatic Coarse
	Kataribhog	BRRI dhan 34	Swarna
Human labor (man-days):	111	110	119
Family	19	20	21
Hired	92	90	98
Seed (Kg):	42	39	50
Owned	36	35	44
Purchase	6	4	6
Fertilizer (Kg):	189	197	284
Urea	76	75	113
TSP	36	47	75
MP	50	50	58
Gypsum	23	21	33
ZnSo ₄	4	4	5
Farm yard manure (kg)	1,734	1,968	2,107
Owned	1,127	1,181	1,306
Purchase	607	787	801

Source: Farm household survey, 2011.

3.2.2. Cost Structure

Table 2 shows the per hectare cost of aromatic and non-aromatic coarse rice production in Dinajpur. The per hectare total paid-out cost (TPC) of the coarse variety Swarna was higher than that for aromatic rice cultivation. Similarly reported that the total variable cost (TVC) coarse rice (BST 10,332/ha) was higher than that of aromatic (BDT 9,225/ha) rice [10]. It was observed that the per hectare TPC of aromatic varieties (for BRRI dhan34 and Kataribhog) were consistent; and that the per hectare total imputed cost (TIC) of coarse and aromatic rice were consistent as well. Another finding was that per hectare fertilizers and hired labour cost for coarse rice were higher than that for both the aromatic cultivars. These results indicate that the aromatic cultivars are less fertilizer and labour intensive than the coarse cultivar

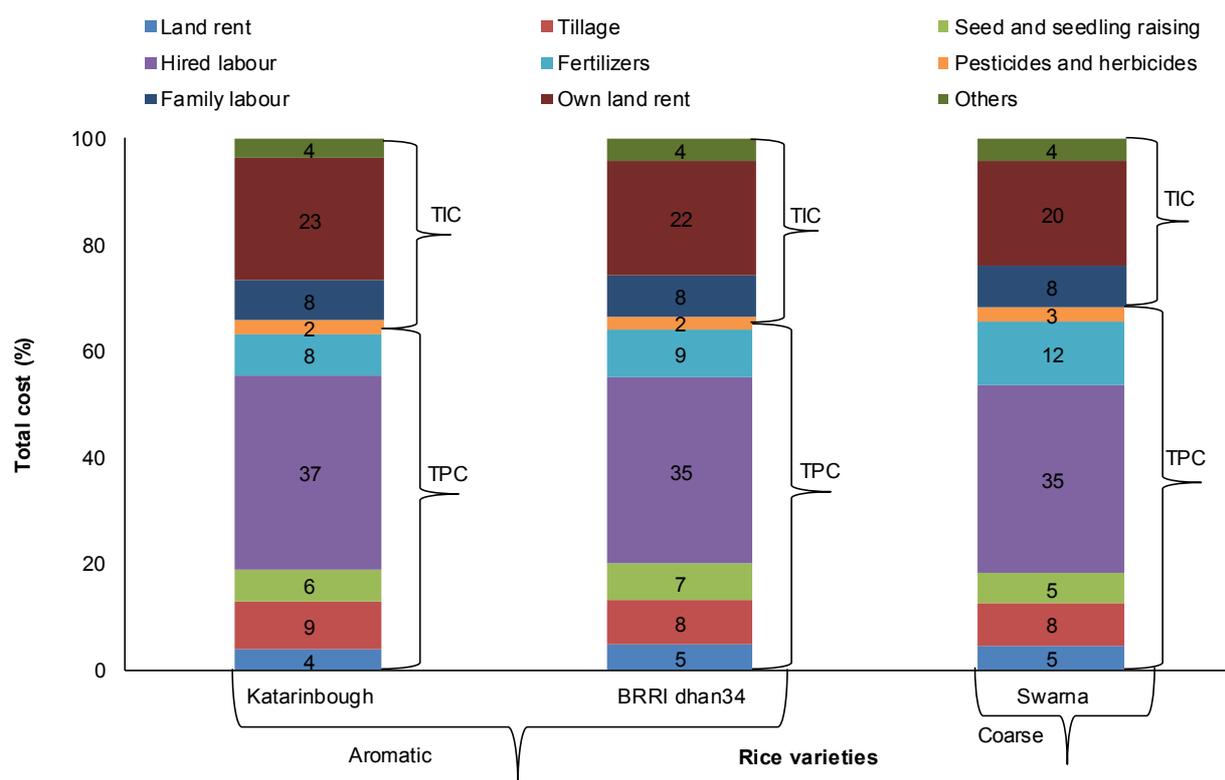
Table 2. Per hectare costs (BDT) of aromatic and coarse monsoon rice cultivation in Dinajpur.

Cost items	Aromatic		Coarse
	BRRI dhan34	Katarinbough	Swarna
Total paid-out cost (BDT/ha):	27,948	26,915	31,160
Land rent	2,270	1,783	2,339
Tillage	3,826	4,136	3,990
Seed and seedling raising	3,162	2,693	2,726
Hired labour	13,319	13,664	14,789

Cost items	Aromatic		Coarse
	BRRI dhan34	Katarinbough	Swarna
Fertilizers	4,251	3,519	5,985
Pesticides	900	940	1,143
Herbicide	220	180	188
Total imputed cost (BDT/ha):	14,791	14,886	14,282
Household seed	519	756	404
Family labour	2,924	2,778	2,282
Household farm yard manure	866	389	1,127
Own land rent	9,954	10,458	9,885
Interest on operating capital	528	505	584
Total cost (BDT/ha):	42,739	41,801	45,442

Source: Farm household survey, 2011.

Figure 1 displays the representation of different inputs in the total cost of cultivation of aromatic and coarse rice varieties. The TPC of aromatic and non-aromatic rice cultivars ranges between 60-63% of total cost cultivation. The representation of inputs in the per hectare total production cost was the highest for hired labour (31-33%), followed by land rent (27-29%), fertilizers (9-13%) and tillage (9-10). Likewise reported that the per hectare human labour cost (BDT 3,236/ha) in TVC/ha of rice cultivation was considerably higher than others, followed by fertilizers (BDT 2,759/ha) and tillage (BDT 2,267/ha) cost [10].



Note: TIC: Total imputed cost TPC: Total paid-out cost.

Figure 1. Representation of inputs in total cost of production in Dinajpur.

3.2.3. Yields and Returns

Table 3 shows the per hectare yields and returns of aromatic and coarse rice cultivation in Dinajpur. The per hectare yields of local aromatic varieties such as Kataribhog

and BRRI aromatic varieties such as BRRI dhan34 were consistent. However, the per hectare yield of the coarse variety Swarna (3.8 t/ha) was largely higher than that of Kataribhog (2.7 t/ha) and BRRI dhan34 (2.6 t/ha). It was

found that the farmers obtained 29 and 31 percent less yield than BRRi dhan34 and Kataribhog, respectively, compared to the popular ‘Swarna’ (Table 5). It was also revealed that the average yield benefit of the aromatic Swarna variety was 1.2 t/ha and 1.1 t/ha, compared to that of BRRi dhan34 and Kataribhog, respectively. Likewise, reported that per hectare yield of coarse rice (3.4 t/ha) was higher than that of aromatic rice (1.6 t/ha) [10]. However, despite these, higher yields, the per hectare returns of coarse variety monsoon rice was largely lower than aromatic variety monsoon rice (Table 2 and 3). This is due to the lower cost of cultivation and higher grain of price of aromatic rice.

The per hectare gross income of BRRi dhan34 (BDT 69,760 t/ha) and Kataribhog (BDT 55,882/ha) were considerably higher than that of Swarna (BDT 50,251/ha), mainly because of the higher grain price of BRRi dhan34 and Kataribhog. Similarly, the net income of BRRi dhan34 (BDT 52,427/ha) was also higher followed by Kataribhog (BDT 39,295/ha) and Swarna (BDT 33,835/ha). The results indicate that BRRi dhan34 is not only a profitable farm enterprise but also an important source of cash income for the rural farm households (Table 3).

Table 3. Per hectare yields and returns of aromatic and non-aromatic coarse monsoon rice cultivation in Dinajpur.

Yield and returns	Aromatic		Coarse
	BRRi dhan34	Kataribhog	Swarna
Yield (t/ha): Grain	2.6	2.7	3.8
Straw	2.2	2.3	3.2
Value of grain	91,490	76,836	73,613
Value of straw	3,921	4,023	4,813
Paddy price (BDT/kg)	35.0	28.5	19.5
Gross benefit (BDT/ha)	95,411	80,859	78,426
Gross income (BDT/ha)	69,760	55,882	50,251
Net income (BDT/ha)	52,427	39,295	33,835

3.2.4. Statistical Significance of Differences in Costs and Returns

Table 4 presents the mean difference of major cost items, cost and returns between BRRi dhan34 and Kataribhog. It was found that there was no significant difference in the per hectare fertilizers, pesticides and human labour cost of BRRi dhan 34 and Kataribhog. However, there was a significant mean difference in the paid-out cost, total cost, gross return and net return per hectare of BRRi dhan 34 and Kataribhog. The results indicate BRRi dha34 incurred higher costs and gave significantly higher returns than Kataribhog.

Table 4. Mean difference t-value between BRRi dhan34 and Kataribhog.

Data	BRRi dhan 34	Kataribhog	Mean difference	t-value	P (T<=t)
Seed (BDT/ha)	3,162	2,693	469 ^{ns}	0.83	0.206
Fertilizer cost (BDT/ha) ²	4,251	3,519	732 ^{ns}	0.692	0.247
Cost of pesticides (BDT/ha)	900	940	-40 ^{ns}	-0.813	0.212
Labour cost (BDT/ha)	16,243	16,442	-199 ^{ns}	-0.573	0.285
Total Paid-out cost (BDT/ha)	27,948	26,915	1,033*	5.315	0.000009
Total cost (BDT/ha)	42,739	41,801	938	1.429	0.082
Gross benefit (BDT/ha)	95,411	80,859	14,552***	4.043	0.00006
Net income (BDT/ha)	52,427	39,295	13,132***	3.88	0.0003

***, * indicates significant at 1% and 10% level.

Table 5 presents the mean difference of major cost items, cost and returns between BRRi dhan34 and Swarna. It was found that BRRi dhan34 incurred significantly lower cost for fertilizers, as well as total cost, compared to Swarna. However,

gross return and net return per hectare of BRRi dhan 34 was significantly higher than Swarna. The results indicate BRRi dha34 incurred lower cost, but gave significantly higher returns than Swarna.

Table 5. Mean difference t-value between BRRi dhan34 and Swarna.

Data	BRRi dhan 34	Swarna	Mean difference	t-value	P (T<=t)
Seed (BDT/ha)	3162	2,726	436***	3.14	0.0013
Fertilizer (BDT/ha)	4251	5,985	-1,734***	-4.12	0.00005
Pesticides (BDT/ha)	900	1,143	-243 ^{ns}	-0.084	0.467
Labour cost (BDT/ha)	16243	17,071	-828 ^{ns}	-0.912	0.365
Total paid-out cost (BDT/ha)	27948	31,160	-3,212*	-1.87	0.032
Total cost (BDT/ha)	42739	45,442	-2,703*	-1.933	0.0289
Gross benefit (BDT/ha)	95411	78,426	16985**	2.52	0.0075
Net income (BDT/ha)	52427	33,835	18592**	2.95	0.0024

***, **, * indicates significant at 1%, 5% and 10% level.

3.2.5. Partial Budget Analysis

Partial budget analysis was done to assess the breakdown of the economic advantage of BRRi dhan34 over Swarna rice. Results of the partial budget analysis between BRRi dhan34 and Swarna rice cultivation indicated that BRRi dhan34 producers could earn an extra benefit of BDT. 20,197/ha by

cultivating BRRi dhan34 rice instead of cultivating Swarna (Table 6).

In the same way, the partial budget analysis was done to assess the breakdown of the economic advantage of BRRi dhan34 over Kataribhog rice, under the aromatic group. Results of the partial budget analysis between BRRi dhan34 and Kataribhog rice cultivation indicated that BRRi dhan34

producers could earn an additional benefit of BDT. 13,519/ha by cultivating BRRI dhan34 rice instead of cultivating Kataribhog (Table 7). Likewise, reported that aromatic rice

gave higher income than that of non-aromatic rice cultivars in Tangial district in Bangladesh [21].

Table 6. Partial budgeting for BRRI dhan34 versus Swarna rice production T. Aman Wet Season.

Items	Debit (BDT/ha)		Items	Credit (BDT/ha)	
	BRRI dhan 34			Swarna	
A. Cost of producing BRRI 34	27,948		A. Cost saved for cultivating Swarna	31,160	
B. Revenue forgone for not growing Swarna	78,426		B. Revenue earned from producing BRRI 34	95,411	
C. Profit	20,197				
Total	126,571			126,571	

Table 7. Partial budgeting for BRRI dhan34 versus Kataribhog rice production in T. Aman Wet Season.

Items	Debit (BDT/ha)		Items	Credit (BDT/ha)	
	BRRI 34			Kataribhog	
A. Cost of producing BRRI 34	27,948		A. Cost saved for cultivating Kataribhog	26,915	
B. Revenue forgone for not growing Kataribhog	80,859		B. Revenue earned from producing BRRI 34	95,411	
C. Profit	13,519				
Total	122,326			122,326	

3.2.6. Risk Analysis

Figure 2 demonstrates the cumulative probability distribution (CDFs) of aromatic and non-aromatic rice in 2011. The lower boundary of CDFs was zero, indicating that net income lower than zero is a total loss; and the upper boundary was selected randomly (BDT 20,000). CDF of BRRI developed aromatic cultivar BRRI dhan34 shows that there is first-degree stochastic dominance over local cultivar aromatic cultivar Kataribhog and the most dominant non-

aromatic cultivar Swarna, while the Kataribhog sows displays second-degree stochastic dominance over Swarna. The results of the risk analysis indicate that the probability of receiving negative net income for T. Aman rice was zero at farmers' perceived variability in yield and price in 2011. It also revealed that BRRI dhan34 has about 100% chance of giving net income over BDT 20,000 per ha, which decreases to 80% for Kataribhog and 73% for Swarna. These results indicate that BRRI dhan34 was economically more viable followed by Kataribhog and Swarna.

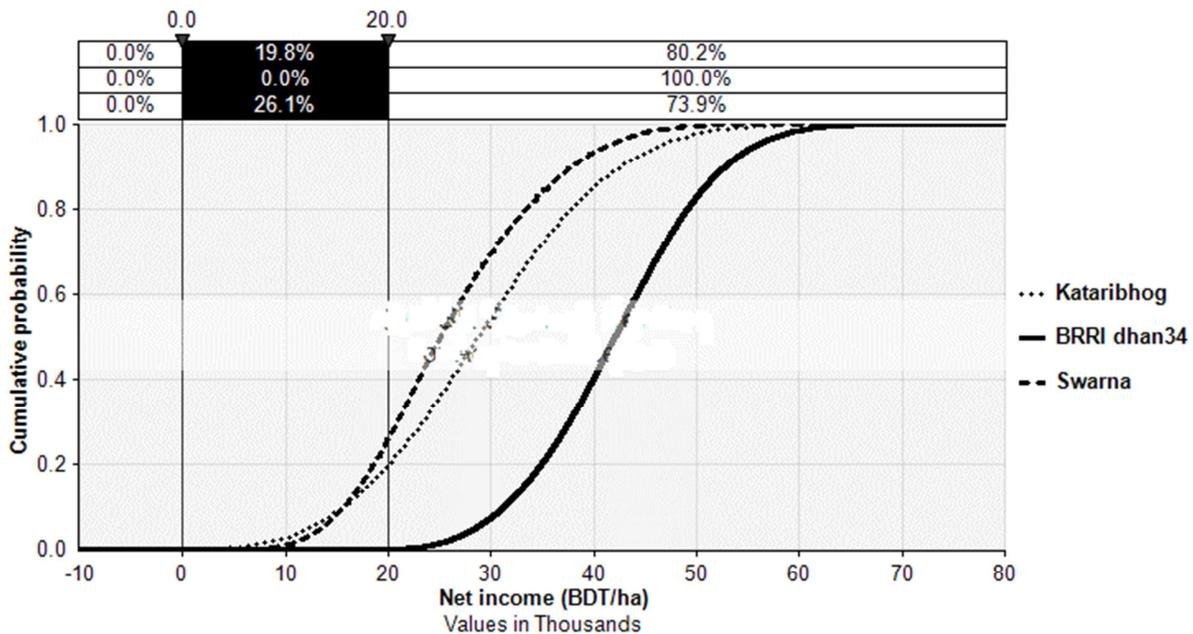


Figure 2. Cumulative probability distribution of net income of aromatic and non-aromatic rice in 2011.

Figure 3 presents the cumulative probability distribution (CDFs) of aromatic and non-aromatic rice in 2017. The lower boundary of CDFs was zero, indicating that net income lower than zero is a total loss. The upper boundary was selected randomly (BDT 28,500). CDF of BRRI developed aromatic

cultivar BRRI dhan34 shows first-degree stochastic dominance over local aromatic cultivar Kataribhog and most dominant non-aromatic cultivar Swarna. The CDFs shows that both Kataribhog and Swarna have in range between 20-23% probabilities of giving negative net income. On the

contrary, the probability of having negative net income for BRRI dhan34 was not only nil, but also, the chance of having net income over the upper boundary (BDT 28,500) was 76%. The key insight of the risk analysis is that the risk of coarse

cultivars increased over time, while the risk of aromatic cultivar BRRI dhan34 is observed stable (Figure 3). It indicates that BRRI dhan34 was economically more viable than that of Kataribhog and Swarna.

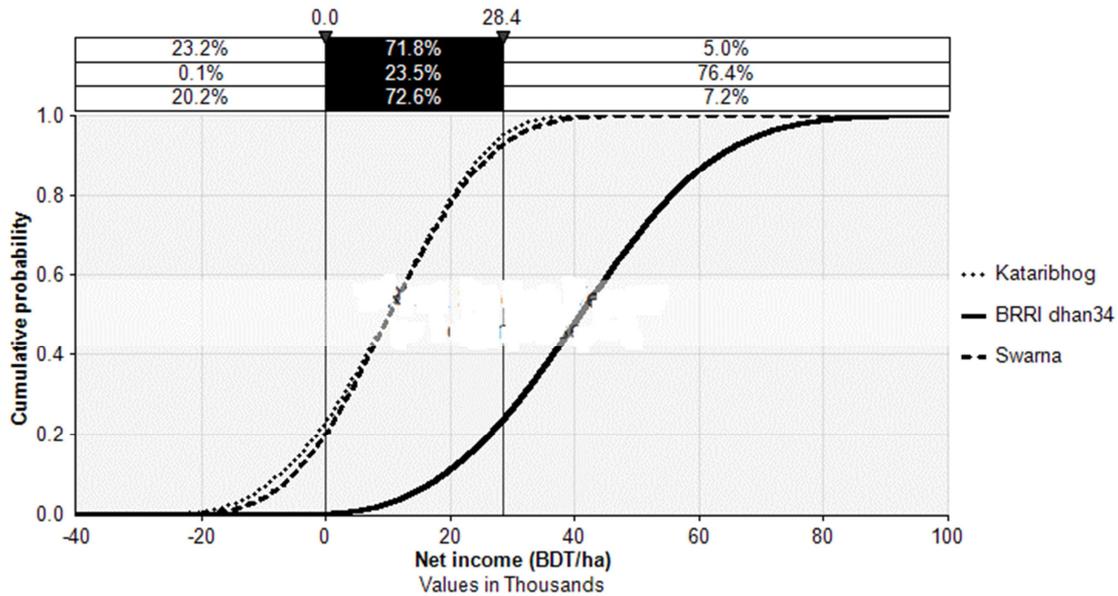


Figure 3. Cumulative probability distribution of net income of aromatic and non-aromatic rice in 2017.

3.3. Criteria and Constraints to Adoption of BRRI Dhan34

Table 8 shows the major criteria of adoption BRRI dhan34. Higher return due to (i) the higher price and ensured market demand, and (ii) less fertilizer intensive farming, are the key economic criteria of adoption BRRI dhan34 reported by the most respondent farmers (70-100%). It can be noted that farmers usually produce aromatic rice for commercial purposes as they get a higher return from it. The survey results revealed that average per farm production of aromatic rice was 2.65 tons, of which only 5 percent was used for home consumption and the rest (95%) was sold.

The social criteria (in particular of scented rice) of BRRI dhan34 is the fact that it is the most favorite dish in the religious and cultural festivals, and this also an important

criterion in favour of the adoption of the variety, as reported by 63-100% of total sample respondents. Furthermore, the key agronomic drivers of adoption of BRRI dhan34 are the suitability for delayed planting, shorter growth duration and less lodging, as reported by 43-93% of total respondents (Table 8).

The major agronomic constraints of adoption of BRRI dhan34 included higher susceptibility to biotic (e.g., pest) and abiotic (droughts) stresses, reported by 57-83% of total farm households. More labour requirements for double transplanting and higher yield sensitivity about the time of fertilizers and pesticides application were also reported by farmers as constraints to the cultivation of BRRI dhan34 (Table 8).

Table 8. Major criteria and constraints of adoption BRRI dhan34 in Dinajpur.

Factors	Criteria	Frequency (n=60)	% of response
Economic	Higher demand and price	30	100
	Profitable	30	100
	Less fertilizer intensive	21	70
	Reasonable yield	11	37
Social	Favorite rice for festival	30	100
	Good for scented rice	19	63
	Suitable for late planting	28	93
Agronomic	Less lodging	14	47
	Shorter lifecycle	13	43
	Availability seed	8	27
	Constraints		
Agronomic	Higher insects and diseases infestation	25	83
	Drought susceptible	17	57
	Bolan is essential	10	33
	Sensitive to time of fertilizer application	5	17
Economic	Relatively low yield	11	37

4. Conclusion

The study revealed that the cultivation of aromatic rice is more profitable at farm level than coarse rice, even with its lower yield than the non-aromatic coarse rice in wet season. Among the two aromatic varieties, BRRI dhan34 was more profitable than the local aromatic Kataribhog. The yield benefit of coarse rice could not earn a higher profit than aromatic varieties because of the higher price of aromatic BRRI dhan34 rice cultivars. The study also indicates that farmers are highly motivated to increase the adoption of BRRI dhan34, as the cultivar was profitable and less risky because of its higher price and ensured market demand. The risk of coarse cultivars increased over time, while the risk of aromatic cultivar BRRI dhan34 remained stable. Along with the taste preference of the consumers, the aromatic cultivars have good potential in the international markets. However, the higher seasonal variation in the price of non-aromatic rice, the severe sensitivity to the pest of both aromatic and non-aromatic cultivars are the major constraints for large scale dissemination of aromatic rice and sustainability for coarse rice. Thus, the development and dissemination of higher yield potential biotic stress tolerant aromatic cultivars, as well as access to the export market should get priority in policy planning for the wellbeing of farm households.

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